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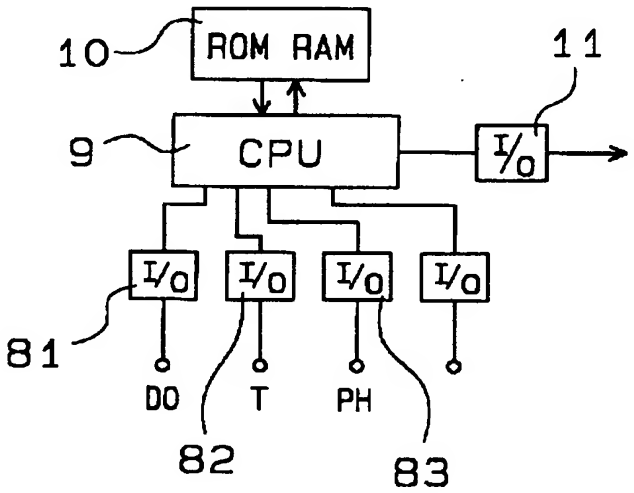
(54)【発明の名称】　排水処理装置

(57)【要約】　(修正有)

【目的】　従来の熟練オペレータのノウハウをコンピュータに取り込んで、排水処理における曝気制御を最適に実行する。

【構成】　産業もしくは家庭排水の排水処理装置において、処理水のＤＯ、温度、発生ガス及びｐＨの少なくとも１つを検出する検出器を設けると共に、該検出器の検出値を設定値と比較した偏差値を曖昧な量として入力するインタフェース81, 82, 83と、入力偏差の変数のために設定した所定数の曖昧制御規則を数値データとして書き込んだ記憶装置10と、該記憶装置のデータを用いて前記インタフェースからの入力値から最適出力を推論選択し各推論結果を合成してＤＯ制御操作量として出力するファジィ推論を実行する中央演算処理装置9 と、該中央演算処理装置の出力をＤＯ制御装置もしくはディスプレイに供給するインタフェース11とから成るファジィ制御器を設けた。



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【特許請求の範囲】

【請求項1】　産業もしくは家庭排水の排水処理装置において、処理水のDO、温度、発生ガス及びpHの少なくとも1つを検出する検出器を設けると共に、該検出器の検出値を設定値と比較した偏差値を曖昧な量として入力するインタフェース(81,82,83)と、入力偏差の変数のために設定した所定数の曖昧制御規則を数値データとして書き込んだ記憶装置(10)と、該記憶装置のデータを用いて前記インタフェースからの入力値から最適出力を推論選択し各推論結果を合成してDO制御操作量として出力するファジィ推論を実行する中央演算処理装置(9)と、該中央演算処理装置の出力をDO制御装置もしくはディスプレイに供給するインタフェース(11)とから成るファジィ制御器を設けたことを特徴とする排水処理装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は排水の処理装置に関する。

【0002】

【従来の技術】食品製造、石油化学等の分野で生じる産業排水とか家庭からの生活排水等を、好気性微生物を使って処理する活性汚泥処理において、通気量の制御については従来より熟練オペレータに頼っている。その場合、オペレータは通常、水温とか発生ガス、pH等を計り、過去の経験に基づいて制御データを解析し、DO制御を行なうようにしている。しかしながら近時コンピュータの発展により、これをコンピュータ化して自動的に制御しようとする試みがなされたが、この熟練オペレータの経験や勘に多くを依存するプロセス制御では、それが数式モデルに乗り切らないため、コンピュータによりPID制御をするわけにはいかなかった。

【0003】

【発明が解決しようとする課題】本発明は従来の熟練オペレータのノウハウをコンピュータに取り込んで、排水処理における曝気制御を最適に実行することを目的とするものである。

【0004】

【課題を解決するための手段】上記の目的は、産業もしくは家庭排水の排水処理装置において、処理水のDO、温度、発生ガス及びpHの少なくとも1つを検出する検出器を設けると共に、該検出器の検出値を設定値と比較した偏差値を曖昧な量として入力するインタフェースと、入力偏差の変数のために設定した所定数の曖昧制御規則を数値データとして書き込んだ記憶装置と、該記憶装置のデータを用いて前記インタフェースからの入力値から最適出力を推論選択し各推論結果を合成してDO制御操作量として出力するファジィ推論を実行する中央演算処理装置と、該中央演算処理装置の出力をDO制御装置もしくはディスプレイに供給するインタフェースとから成るファジィ制御器を設けたことを特徴とする排水処理装置によって達成し得る。

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【0005】

【作用】上記の如く、本発明は、処理水のDO、温度、発生ガス及びpHの少なくとも1つを検出する検出器を設けると共に、該検出器の検出値を設定値と比較した偏差値を曖昧な量として入力するインタフェースと、入力偏差の変数のために設定した所定数の曖昧制御規則を数値データとして書き込んだ記憶装置と、該記憶装置のデータを用いて前記インタフェースからの入力値から最適出力を推論選択し各推論結果を合成してDO制御操作量として出力するファジィ推論を実行する中央演算処理装置と、該中央演算処理装置の出力をDO制御装置もしくはディスプレイに供給するインタフェースとから成るファジィ制御器を設けたことを特徴とするものであるから、曝気制御に関する熟練オペレータのノウハウを取り入れてコンピュータ制御することができ、このようなコンピュータによる自動制御によって常に最良のDO制御が可能となり、安定した排水処理を達成できるものである。

【0006】

【実施例】以下、図面を参照しつゝ本発明を具体的に説明する。図1は活性汚泥による生活排水処理のプロセスである。通常、生活排水中の80%は水分、残り20%が固形物であり、そして、この固形物中の90%は炭水化物、脂肪、タンパク質、核酸等の有機物であり、10%が無機物である。無機物にはP_2O_5 50%、SO_2 15%、Na_2O 11%、CaO 9%、MgO、K_2O、Fe_2O_3等が含まれる。排水1は沈澱槽に導入されて沈澱処理2され、次にこのような排水中に単細胞の原生生物等を含む活性汚泥3を加えて処理する。活性汚泥は好気性微生物の集落で、バクテリア等の細菌が最も多く、繊毛虫類などの原生生物が含まれている。このような活性汚泥を混合した排水を曝気4すると、有機物は酸化されて活性汚泥に吸着抑留され、酵素の働きで徐々に微生物の栄養となって摂取される。このようにして有機物は次第に微生物に転化し、活性汚泥は増殖する。処理された排水は再び沈澱処理5され、分離された上澄は放流6され、沈殿した汚泥はルート7を経て返送されて循環して排水処理に利用される。

【0007】以上のような活性汚泥による作用を利用して有機系排水の処理を行なうが、この処理は微生物の酸化増殖作用による処理であるため多量の酸素供給が必要であり、これによって処理効率が大きく相違してくる。又、有機物の質、基質濃度等によっても処理効率は異なってくる。微生物の生死によりpHが変化し、又、温度が10℃上がれば約2倍の活性化が行なわれ、反応速度は一般に$\sqrt{T}$に比例して進行するので、この温度係数を考慮に入れて処理することが必要である。従来このような場合における通気量の制御は、熟練したオペレータの経

験や勘に依存して行なわれていたが、本発明はこれを制御規則としてファジィ制御するものである。

【０００８】図２には、本発明に係る排水処理装置に用いられるファジィ制御器の一実施例が示されている。本発明においては、先ず始めに、曝気処理される前、或いは後の処理水（排水）中にセンサを挿入して排水のＤＯを測定する。清浄な水には通常７～14ｐｐｍのＤＯが含まれており、この範囲において規準設定値をインタフェースＩ／Ｏ 81 に設定する。インタフェースＩ／Ｏ 81 は検出値と設定値を比較した偏差Ｅを曖昧な量として入力する機能を有する。入力信号はＣＰＵ（中央演算処理装置）９に入力し、ファジィ推論が実行される。10は所定数の曖昧制御規則を書き込んだファジィメモリであり、この内容は経験的に決定する。基本ルールは、偏差Ｅ、Δｔ時間に偏差の変化分がΔＥ、操作量の変化分がΔｕであるとき、

１：　Ｅ＝０　ａｎｄ　ΔＥ＝ＰＢ　→　Δｕ＝ＮＢ
２：　Ｅ＝ＰＢ　ａｎｄ　ΔＥ＝０　→　Δｕ＝ＮＢ
３：　Ｅ＝０　ａｎｄ　ΔＥ＝ＮＢ　→　Δｕ＝ＮＢ
４：　Ｅ＝ＮＢ　ａｎｄ　ΔＥ＝０　→　Δｕ＝ＰＢ　＊20
＊５：　Ｅ＝０　ａｎｄ　ΔＥ＝０　→　Δｕ＝０

これを表にまとめれば次のようになる。

【０００９】

【表１】

		ΔE		
		NB	0	PB
E	PB		NB	
	0	PB	0	NB
	NB		PB	

【００１０】更に熟練オペレータのノウハウを入れて改良すると表２の制御規則をつくることができる。

【００１１】

【表２】

		ΔE						
		NB	NM	NS	0	PS	PM	PB
E	PB	1	0	−1	−2	−3	−4	−5
	PM	2	1	0	−1	−2	−3	−4
	PS	3	2	1	0	−1	−2	−3
	0	3	2	1	1	0	−1	−3
	NS	4	3	2	2	1	0	−2
	NM	5	4	3	3	2	1	1
	NB	5	5	3	3	2	1	1

【００１２】図２において、11はＣＰＵ９の出力を曝気装置等に供給するためのインタフェースである。ＣＰＵ９はＤＯの偏差値及びΔＥをＩ／０ 81 から入力し、この入力値から最適出力を推論選択するファジィ推論を実行する。こうして選択した操作量の変化分をＤＯ制御のために出力しインタフェース11を通してエアレーション用のモーター制御等を行う。

【００１３】又、処理水の検出信号としては、処理水の温度（Ｔ）や、発生ガスの種類、例えばCO_2、H_2S、アンモニア等の検出、或いはｐＨ検出も同時に行なうことができる。このような検出値の偏差は他のインタフェース82、83、・・・を通して入力しＣＰＵ９によりファジィ推論を実行する。各入力偏差の変数のためにもメモリ10に所定数の曖昧制御規則を離散的な数値データとして書き込んでおき、それを入力値から最適出力を推論選択する。各推論結果はそれを合成して所要の操作量として出力する。この各ルールで得た推論結果を合成するには、重心法とか加重平均法が用いられるが、前者の重心法は定性的に理解しやすく、数式化しにくい制御に有効である。ＣＰＵ９の出力はインタフェース11を経て曝気用のモータ制御回路に出力されるが、出力をディスプレイに表示してオペレータと対話形式で制御器の操

作をすることができる。画面がディスプレイ上に表示され、常にどの規則が主に働いているかすぐわかるようにすることができる。ディスプレイ部はスイッチの切換えにより、制御量、操作量、設定値を表示するほか、サンプリング時点で最も効いている制御規制の番号を表示する。なお、処理水のｐＨは菌類、微生物等の生死によって４～9.5 の範囲で変化するが、通常は 6.5～７程度がよく、酵素反応の活性はｐＨ、温度等によって変化する。

【００１４】又、発生ガスは、分解、酸化、還元等の反応によって発生し、例えば藻類の光合成により、

$CO_2 + 2H_2O \rightarrow CH_2O + O_2 + H_2O$

$CH_2O + O_2 \rightarrow CO_2 + H_2O$

という反応が行なわれてCO_2 ガスが発生する。又、酵素反応によっても下記の如く各種ガスが発生する。

$C_6H_{12}O_5 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

$2NH_4 + 2O_2 \rightarrow 4H_2O + N_2$

$5S + 2H_2O + 6NO_3 \rightarrow 5SO_4 + 3N_2 + 4H$

【００１５】図３は好気性サイクルを示すもので、窒素化合物、炭素化合物、硫黄の分解によってアンモニア、CO_2 、H_2 Ｓが生成し、その酸化、分解、還元によって硝酸、CO_2 、硫黄が発生する。従ってこのような発生ガスを各々センサで検知して、その偏差をＣＰＵ９に入力し、ファジィ推論を実行することによってオペレータの経験に基づいた最良のＤＯ制御の信号入力を得ることができ、長年の経験や勘の積み重ねによる知識をコンピュータ制御に利用して最良の排水処理を行ない得るものである。

【００１６】以上は好気性処理についてファジィ制御を利用して処理することについて説明したが、活性汚泥とは異なる嫌気性細菌を用いて排水中の有機物をメタンガスCH_4 と炭酸ガスCO_2 に分解する嫌気性処理の場合にも同様にファジィ制御を利用することができる。なおこの嫌気性処理の場合はＤＯ値を常に一定値以下に保つようにすればよい。

【００１７】

【発明の効果】以上のように本発明は排水処理において、処理水のＤＯ、温度、発生ガス及びｐＨの少なくとも１つを検出する検出器を設けると共に、該検出器の検出値を設定値と比較した偏差値を曖昧な量として入力するインタフェースと、入力偏差の変数のために設定した所定数の曖昧制御規則を数値データとして書き込んだ記憶装置と、該記憶装置のデータを用いて前記インタフェースからの入力値から最適出力を推論選択し各推論結果を合成してＤＯ制御操作量として出力するファジィ推論を実行する中央演算処理装置と、該中央演算処理装置の出力をＤＯ制御装置もしくはディスプレイに供給するインタフェースとから成るファジィ制御器を設けたことを特徴とするものであるから、熟練オペレータの経験、勘のノウハウを制御に取り入れて、コンピュータによる自動制御により常に最良のＤＯ制御をすることができる。従って好気性微生物を用いた場合は最良のＤＯ制御により酸化増殖作用を盛んにして処理効率を高め、逆に嫌気性処理の場合はＤＯ値を常に一定値以下に保つようにして安定した処理効果を得るようにすることができる効果がある。

【図面の簡単な説明】

【図１】本発明に係る排水処理装置の一実施例のプロセス構成図である。

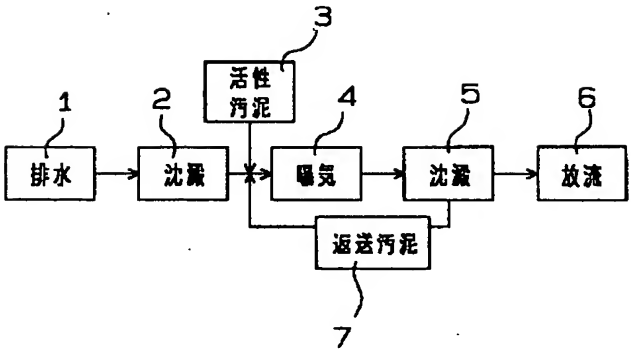
【図２】本発明に係る排水処理装置のファジィ制御器の一実施例の構成図である。

【図３】本発明に係る排水処理装置において実施される好気性サイクルの説明図である。

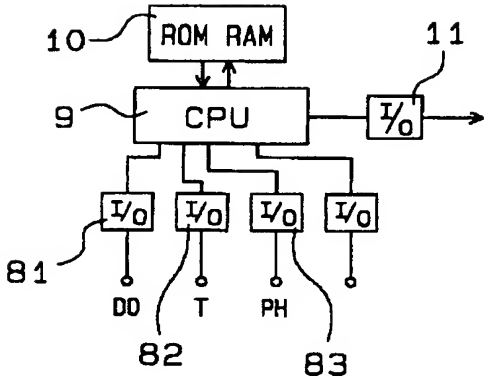
【符号の説明】

1	排水
2, 5	沈澱槽
3, 7	活性汚泥
4	曝気槽
6	放流
81, 82, 83	インタフェース
9	ＣＰＵ
10	記憶装置
11	インタフェース

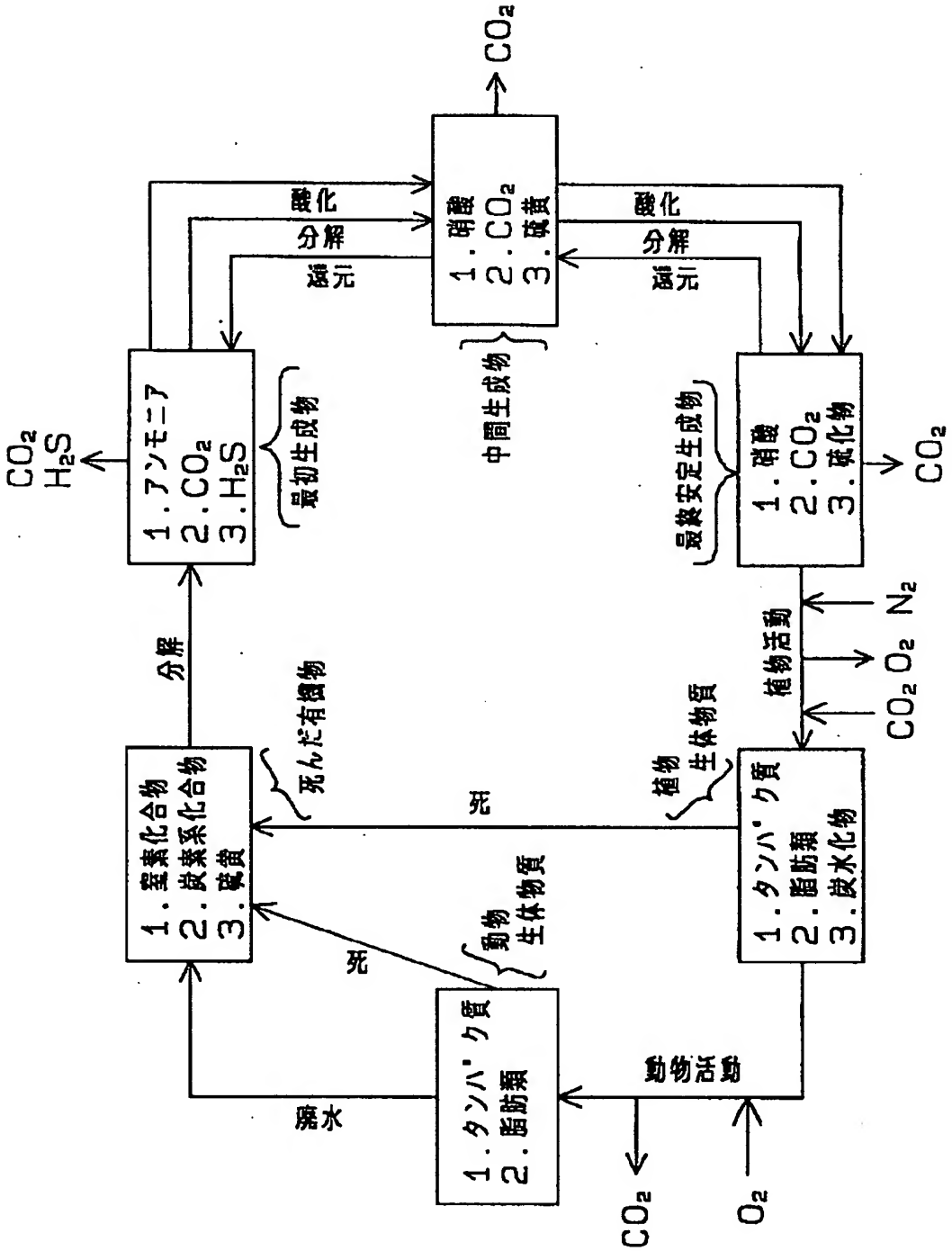
【図１】


3
活性汚泥
1
2
4
5
6
排水
沈澱
曝気
沈澱
放流
返送汚泥
7

【図２】


10
ROM RAM
11
9
CPU
I/O
I/O
I/O
I/O
I/O
81
DO
T
PH
82
83

【図３】


CO_2
1．硝酸
2．CO_2
3．硫黄
酸化
分解
還元
酸化
分解
還元
中間生成物
1．アンモニア
2．CO_2
3．H_2S
最初生成物
CO_2
H_2S
最終安定生成物
1．硝酸
2．CO_2
3．硫化物
CO_2
N_2
植物活動
CO_2 O_2
分解
死んだ有機物
植物
生体物質
死
1．窒素化合物
2．炭素系化合物
3．硫黄
1．タンパク質
2．脂肪類
3．炭水化物
死
動物
生体物質
動物活動
廃水
1．タンパク質
2．脂肪類
CO_2
O_2

Full English translation of text portions of
JP-A-5-237491 (Ref.2)

(page 2, left column, line 1 to page 4, right column, line 36)

SPECIFICATION

[Title]

WASTEWATER TREATMENT INSTALLATION

[Claims]

1. An installation for treatment of wastewater from industries or houses, comprising: a detector to detect at least one of DO, temperature, generated gases, and pH of the object wastewater to be treated; and a fuzzy controller including interfaces 81, 82 and 83 into which deviation values obtained by comparing the detected values of the detector with the set values are input as fuzzy values, a memory apparatus 10 on which a predetermined number of fuzzy control regulations set for the variable of an input deviation is written down as numerical data, a central processing unit 9 to execute fuzzy inference in which using data of the memory apparatus the optimum output is inferred and selected from the input values of the interfaces, and the inference results are combined to be output as an amount of DO control operation, and an interface 11 to supply the output of the central processing unit to a DO controller or a display.

[Detailed Description of Invention]

[0001]
[Industrial Applicability]
The present invention relates to a wastewater treatment installation.

[0002]
[Prior Art]
In a treatment of an active sludge to treat industrial wastewater generated in fields such as food manufacturing and petrochemistry or domestic wastewater from houses using aerobic bacteria, control of the quantity of air flow has been relied on a skilled operator. In this case, usually, the operator measures water temperature, generated gas, pH, and the like, analyzes control data based on the past experience, and carries out DO control. However, from the recent development of computers, although it has been tried to execute the control automatically with a computer, since the process control being largely relied

on the experience and the feel of the skilled operator is not expressed in a mathematical model, PID control with a computer could not be achieved.

[0003]
[Problems to be solved by Invention]
The object of the present invention is to put the know-how of a conventional skilled operator into use for a computer so as to execute optimum aeration control of wastewater treatment.

[0004]
[Means for solving Problems]
The above object can be achieved by an installation for treatment of wastewater for industrial wastewater or for domestic wastewater, in which a detector to detect at least one of DO, temperature, generated gases, and pH of the wastewater to be treated is installed; and at the same time a fuzzy controller is installed, including interfaces into which deviation values obtained by comparing the detected values of the detector with the set value as fuzzy values, a memory apparatus on which a predetermined number of fuzzy control regulations which are set for the variable of an input deviation is written down as numerical data, a central processing unit to execute fuzzy inference in which using data of the memory apparatus the optimum output is inferred and selected from the input value of the interfaces, and the inference results are combined to be output as an amount of DO control operation, and an interface to supply the output of the central processing unit to a DO controller or a display.

[0005]
[Action]
As mentioned above, in the present invention, a detector to detect at least one of DO, temperature, generated gases, and pH of the object wastewater to be treated is installed; and at the same time a fuzzy controller is installed, including interfaces into which an input deviation value obtained by comparing the detected values of the detector with the set values as fuzzy values, a memory apparatus on which a predetermined number of fuzzy control regulations which are set for the variable of an input deviation is written down as numerical data, a central processing unit to execute fuzzy inference in which using data of the memory apparatus, the optimum output is inferred and selected from the input values of the interfaces, and the inference results are combined to be output as an amount of DO control operation, and an

interface to supply the output of the central processing unit to a DO controller or a display. Therefore, automatic computer control in which the know-how of a skilled operator regarding to aeration control is put into use for a computer can be achieved, and this always allows optimum DO control, enabling a stable treatment of wastewater to be achieved.

[0006]
[Embodiment Example]

Hereinafter, with reference to drawings, the present invention will be described specifically. Fig. 1 is a view illustrating a process of a domestic wastewater treatment by active sludge. Usually, the domestic wastewater contains 80% of water and 20% of residual solids, where, 90% of the solids are composed of organic substances such as carbohydrates, fats, proteins, and nucleic acids, and 10% of the solids are composed of inorganic substances, in which 11% of Na_2O, 9% of CaO, MgO, K_2O, Fe_2O_3, etc. are contained. Wastewater 1 is introduced into a settling tank and subjected to a settling treatment 2, next, such wastewater is added with active sludge 3 containing unicellular protists etc. and treated. The active sludge is a colony of aerobic microbes where germs such as bacteria are contained mostly and protests such as ciliata are also contained. If wastewater mixed with such active sludge is subjected to aeration 4, the organic substances are oxidized and absorbed and constrained by the active sludge, and gradually ingested by microbes as nutritions by the action of an enzyme. In this manner, the organic substances are gradually converted into microbes and the active sludge grows. The treated wastewater is subjected to a settling treatment 5 again, the separated supernatant water is discharged (6), the settled sludge is returned through a route 7 and circulated to be utilized for the wastewater treatment.

[0007]

Although, organic substance-based wastewater is treated by utilizing the action of the active sludge as mentioned above, since the treatment utilizes oxidation-growth action of microbes, much oxygen is required to be supplied to the wastewater, this causes the treatment efficiency to be varied largely. Moreover, the quality and the substrate concentration of the organic substances or the like cause the treatment efficiency to be varied. Since, the pH of the sludge changes depending on the life and death of the microbes, as the temperature increases by 10 degrees centigrade the sludge is activated by about

twice, and in general the reaction rate is proportional to the root of temperature T, it is necessary to treat the wastewater by consider ing the temperature coefficient. Conventionally, the control of the quantity of airflow in such a case has been performed by relaying on the experience and the feel of a skilled operator, however, in the present invention, the control is performed fuzzily as a control regulation.

[0008]

In Fig. 2, one embodiment example of a fuzzy controller used for the wastewater treatment installation according to the present invention is illustrated. In the present invention, first, by inserting a sensor in wastewater before subjected to an aeration treatment or treated water (wastewater after treated), DO of the wastewater is measured. In clean water, usually, 7 to 14 ppm DO is contained, thereby, a reference set value within the range is set in an interface I/O 81. The interface I/O 81 has a function of being input with deviation E when the detected value and the set value are compared, as a fuzzy amount. An input signal is input into a CPU (central processing unit) 9, and fuzzy inference is executed. Reference numeral 10 is a fuzzy memory in which a predetermined number of fuzzy control regulations are written down, the content thereof is determined empirically. The basic rule of this, when deviation is denoted as E, changed amount of the deviation in a time Δt is denoted as ΔE, and changed amount of operation amount is denoted as Δu, is represented as follows.

1: E = 0 and ΔE = PB $\rightarrow$ Δu = NB
2: E = PB and ΔE = 0 $\rightarrow$ Δu = NB
3: E = 0 and ΔE = NB $\rightarrow$ Δu = NB
4: E = NB and ΔE = 0 $\rightarrow$ Δu = PB
5: E = 0 and ΔE = 0 $\rightarrow$ Δu = 0

These control regulations are summarized in Table 1.

[0009]

Table 1

		ΔE		
		NB	0	PB
E	PB		NB	
	0	PB	0	NB
	NB		PB	

[0010]

Further, if these control regulations are modified by incorporating the know-how of a skilled operator, control regulations given in Table 2 can be made.

[0011]

Table 2

		ΔE						
		NB	NM	NS	0	PS	PM	PB
E	PB	1	0	-1	-2	-3	-4	-5
	PM	2	1	0	-1	-2	-3	-4
	PS	3	2	1	0	-1	-2	-3
	0	3	2	1	1	0	-1	-3
	NS	4	3	2	2	1	0	-2
	NM	5	4	3	3	2	1	1
	NB	5	5	3	3	2	1	1

[0012]

In Fig. 2, reference numeral 11 is an interface for supplying the output of the CPU 9 to an aeration apparatus etc. Being input with the deviation value of DO and ΔE from an interface 81, the CPU 9 executes fuzzy inference for inferring and selecting optimum output from the input value. The changed amount of the operation amount thus selected is output for the purpose of DO control, and motor control for aeration is performed through the interface 11.

[0013]

Moreover, as for the detection signals of the treated water, detection of temperature T of the treated water and kinds of generated gases such as CO_2, H_2S, ammonia, or detection of pH can also be performed at the same time. Being input with the deviation of such detection values through the other interfaces 82, 83, ‥, the CPU 9 executes fuzzy inference. Also for the variations of each input deviation, a predetermined number of fuzzy control regulations are written down in a memory apparatus 10 as discrete numerical data in advance, and optimum output is inferred and selected from the input values. The inference results are combined and output as a desired operation amount. In order to combine the inference results obtained from each of the rules, a barycentric method or a weighted average method are used, and the former barycentric method is easily understood quantitatively, thereby, it is effective for such control that is hardly mathematized. The output of the CPU 9 is output into a motor control circuit for aeration via the interface 11, and it is possible to display the output on a display to operate the controller interactively with an operator. Since an image screen is displayed on a display, it is always possible to see immediately which rule is mainly working. Other than the control amount, the operation amount, and the set value, the display section displays the number of such a

control regulation that is most effective during sampling by switching a switch. In addition, although the pH of the treated water changes within a range of 4 to 9.5 depending on the life and death of the fungi, microbes or the like, usually, it should be an order of 6.5 to 7, the activity of the enzyme reaction changes depending on pH, temperature, or the like.

[0014]

Moreover, the generated gas is generated by reactions such as decomposition, oxidation, or reduction, for example, by photonic synthesis of algae, the following reaction ocuurs and CO_2 gas is generated.

$$CO_2 + 2H_2O \rightarrow CH_2O + O_2 + H_2O$$

$$CH_2O + O_2 \rightarrow CO_2 + H_2O$$

Moreover, various kinds of gases are also generated by an enzyme reaction as follows.

$$C_6H_{12}O_5 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

$$2NH_4 + 2O_2 \rightarrow 4H_2O + N_2$$

$$5S + 2H_2O + 6NO_3 \rightarrow 5SO_4 + 3N_2 + 4H$$

[0015]

Fig. 3 illustrates an aerobic cycle, by decomposition of nitride compounds, carbon compounds, and sulfur, CO_2, and H_2S are generated, and by oxidation, decomposition, and reduction of them, nitric acid, CO_2, and sulfur are generated, respectively. Such generated gases are detected by sensors, the deviation thereof is input into the CPU 9, and fuzzy inference is executed, accordingly, this enables signal input of optimum DO control on the basis of the experience of an operator to be obtained, thus, enabling computer control of an optimum wastewater treatment utilizing knowledge obtained from many years of experiences and feels to be performed.

[0016]

As above, an aerobic treatment utilizing fuzzy control has been described, however, in case of an anerobic treatment in which organic substances in wastewater are decomposed into methane gas CH_4 and carbon dioxide CO_2 utilizing anaerophyte being different from the active sludge, the fuzzy control can also be utilized. In addition, in the case of the anerobic treatment, DO value should be made always equal to or smaller than a constant value.

[0017]

[Effect of the Invention]

As mentioned above, in a wastewater treatment

installation of the present invention, a detector to detect at least one of DO, temperature, generated gases, and pH of the object wastewater to be treated is installed; and at the same time a fuzzy controller is installed, including, interfaces into which a deviation value obtained by comparing the detected values of the detector with the set values are input as fuzzy values, a memory apparatus on which a predetermined number of fuzzy control regulations which is set for the variable of an input deviation is written down as numerical data, a central processing unit to execute fuzzy inference in which using data of the memory apparatus the optimum output is inferred and selected from the input value of the interfaces, and an interface to supply the output of the central processing unit to a DO controller or a display, thereby it is always possible to perform optimum DO control by automatic control of computer in which know-how of the experiences and feels of skilled operators is put into for use thereof. Accordingly, there are effects in that when aerobatic microbes are used, oxidation-growth action is enhanced by optimum DO control to enhance the efficiency of the treatment, on the contrary, when the anerobic treatment is used, DO value can be made always equal to or smaller than a constant value, enabling a stable treatment effectiveness to be obtained.

[Brief Description of Drawings]

Fig. 1 is a block diagram of a process of an embodiment example of an wastewater treatment installation according to the present invention;

Fig. 2 is a block diagram of an embodiment example of a fussy controller for the wastewater treatment installation according to the present invention; and

Fig. 3 is a schematic diagram of an aerobic cycle carried out in the wastewater treatment installation according to the present invention.

[Description of Reference Numerals]

1	WASTEWATER
2, 5	SETTLING TANK
3, 7	ACTIVE SLUDGE
4	AERATION TANK
6	DISCHARGE
81, 82, 83	INTERFACE
9	CPU
10	MEMORY APPARATUS
11	INTERFACE

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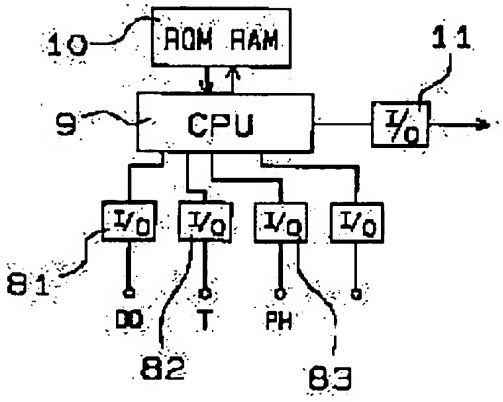
(54) WASTEWATER TREATMENT INSTALLATION

(57)Abstract:

PURPOSE: To put skilled operator's know how into use for a computer and carry out aeration control of wastewater treatment most properly by detecting proper parameters of object wastewater to be treated and deduce optimum output fuzzily based on the detection results.

CONSTITUTION: In an installation for treatment of wastewater from industries or houses, a detector to detect at least one of DO, temperature, propagated gases, and pH of object wastewater to be treated is installed and at the same time a fuzzy controller having a specified structure is installed. The fuzzy controller sends out, as fuzzy values, the deviation values obtained by comparing the detected values of the detector with the set values through the respective interfaces 81-83. Meanwhile, the fuzzy control regulation of a set tank which is set for the variable of an input deviation is written down as a numerical data on a memory apparatus 10. Also, the optimum output is deduced from the input value fuzzily to a central computing apparatus 9 using memory data. Further, the deduced results are supplied to a DO control apparatus or a display through an interface 11.



LEGAL STATUS

[Date of request for examination]

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[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] While forming the detector which detects at least one of DO of treated water, temperature, generating gas, and the pH in the waste water treatment equipment of industry or domestic effluent The interface which inputs a variation [set point / value / of this detector / detection] as an ambiguous amount (81, 82, 83), The storage which wrote in the ambiguous control regulation of the predetermined number set up for the variable of input deflection as numeric data (10), arithmetic and program control (9) which performs fuzzy reasoning which makes inference selection of the optimal output from the input value from said interface using the data of this store, compounds each inference result, and is outputted as an amount of DO control operation The waste water treatment equipment characterized by forming the fuzzy control machine which consists of the interface (11) which supplies the output of this arithmetic and program control to DO control device or a display.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the processor of wastewater.
[0002]
[Description of the Prior Art] In the activated sludge treatment which processes industrial wastewater, domestic wasted water from a home, etc. which are produced in fields, such as food manufacturing and petrochemistry, using aerobic bacteria, it depends on the skillful operator conventionally about control of quantity of airflow. In that case, usually an operator measures water temperature, generating gas, pH, etc., analyzes control data based on the past experience, and is made to perform DO control. However, by the process control which depends on experience of this skillful operator or intuition for many, although the attempt which is going to computerize this and it is going to control by development of a computer automatically recently was made, since it did not overcome to a mathematical model, PID control was not able to be carried out by computer.
[0003]
[Problem(s) to be Solved by the Invention] This invention downloads the conventional skillful operator's know-how to a computer, and aims at performing aeration control in waste water treatment the optimal.
[0004]
[Means for Solving the Problem] While the above-mentioned purpose forms the detector which detects at least one of DO of treated water, temperature, generating gas, and the pH in the waste water treatment equipment of industry or domestic effluent The interface which inputs a variation [set point / value / of this detector / detection] as an ambiguous amount, The storage which wrote in the ambiguous control regulation of the predetermined number set up for the variable of input deflection as numeric data, The arithmetic and program control which performs fuzzy reasoning which makes inference selection of the optimal output from the input value from said interface using the data of this store, compounds each inference result, and is outputted as an amount of DO control operation, The waste water treatment equipment characterized by forming the fuzzy control machine which consists of the interface which supplies the output of this arithmetic and program control to DO control device or a display can attain.
[0005]
[Function] While this invention forms like the above the detector which detects at least one of DO of treated water, temperature, generating gas, and the pH The interface which inputs a variation [set point / value / of this detector / detection] as an ambiguous amount, The storage which wrote in the ambiguous control regulation of the predetermined number set up for the variable of input deflection as numeric data, The arithmetic and program control which performs fuzzy reasoning which makes inference selection of the optimal output from the input value from said interface using the data of this store, compounds each inference result, and is outputted as an amount of DO control operation, Since it is characterized by forming the fuzzy control machine which consists of the interface which supplies the output of this arithmetic and program control to DO control device or a display Computer control of the know-how of the skillful operator about aeration control can be taken in and carried out, the best DO control is always attained by the automatic control by such computer, and the stable waste water treatment can be attained.
[0006]

[Example] Hereafter, with reference to a drawing, **** this invention is explained concretely. Drawing 1 is the process of the domestic-wasted-water processing by active sludge. Usually, moisture and remaining 20% of 80% in domestic wasted water is a solid, and 90% in this solid is the organic substance, such as a carbohydrate, a fat, protein, and a nucleic acid, and 10% is an inorganic substance. an inorganic substance -- P2 O5 50%, SO2 15%, Na2 O 11 %, CaO 9%, MgO, K2 O, and Fe 2O3 etc. -- it is contained. Wastewater 1 is introduced into a settling tank, is carried out precipitation processing 2, and adds and processes the active sludge 3 which contains a unicellular protist etc. during such wastewater next. In the cluster of aerobic bacteria, active sludge has most bacteria, such as bacteria, and protists, such as Ciliata, are contained. If wastewater which mixed such active sludge is carried out aeration 4, the organic substance oxidizes, adsorption detention will be carried out at active sludge, and by work of an enzyme, will serve as a nutrition of a microorganism gradually and will be taken in. Thus, the organic substance is gradually converted into a microorganism and active sludge is increased. Processed wastewater is carried out precipitation processing 5 again, the separated supernatant is carried out discharge 6, precipitating sludge is returned through the root 7, and it circulates through it, and it is used for waste water treatment.

[0007] Although organic system wastewater is processed using the operation by the above active sludge, since it is processing by the oxidation multiplication of a microorganism, this processing needs a lot of oxygen supply, and processing effectiveness is greatly different with this. Moreover, processing effectiveness changes with the quality of the organic substance, substrate concentration, etc. Since twice [about] as many activation as this will be performed and a reaction rate will generally advance in proportion to rootT if pH changes with the life and death of a microorganism and temperature goes up by 10 degrees C, it is required to process taking this temperature coefficient into consideration. Although control of the quantity of airflow in such [conventionally] a case was performed depending on experience of the skilled operator or intuition, this invention makes this a control regulation and carries out fuzzy control.

[0008] One example of the fuzzy control machine used for the waste water treatment equipment concerning this invention is shown in drawing 2 . In this invention, first, before aeration processing is carried out, a sensor is inserted into next treated water (wastewater), and DO of wastewater is measured. 7-14 ppm DO is usually contained in pure water, and it sets in this range, and is the standard set point Interface I/O 81 It sets up. Interface I/O 81 It has the function to input the deflection E which compared the detection value with the set point as an ambiguous amount. An input signal is inputted into CPU (arithmetic and program control)9, and fuzzy reasoning is performed. 10 is the fuzzy memory which wrote in the ambiguous control regulation of a predetermined number, and these contents are determined experientially. When a changed part of deflection is [deltaE and a changed part of a cardinal rule of a control input] deltau in deflection E, and delta t hours, 1 : E= 0 and deltaE=PB -> deltau=NB2: E=PB and deltaE=0 and deltaE=0 -> deltau=0 -- it is as follows if this is summarized in a table. -> deltau=NB3: E= 0 and deltaE=NB -> deltau=NB4: E=NB and deltaE=0 -> deltau=PB5: E= 0

[0009]

[Table 1]

		ΔE		
		NB	0	PB
E	PB		NB	
	0	PB	0	NB
	NB		PB	

[0010] Furthermore, if a skillful operator's know-how is put in and improved, the control regulation of Table 2 can be built.

[0011]

[Table 2]

		ΔE						
		NB	NM	NS	0	PS	PM	PB
E	PB	1	0	−1	−2	−3	−4	−5
	PM	2	1	0	−1	−2	−3	−4
	PS	3	2	1	0	−1	−2	−3
	0	3	2	1	1	0	−1	−3
	NS	4	3	2	2	1	0	−2
	NM	5	4	3	3	2	1	1
	NB	5	5	3	3	2	1	1

[0012] In drawing 2 , 11 is an interface for supplying the output of CPU9 to aeration equipment etc. CPU9 -- the variation of DO, and deltaE -- I/O 81 from -- it inputs and fuzzy reasoning which makes inference selection of the optimal output from this input value is performed. In this way, it outputs for DO control of a changed part of the selected control input, and the motor control for aeration etc. is performed through an interface 11.

[0013] Moreover, as a detecting signal of treated water, detection of the temperature (T) of treated water and the class 2 of generating gas, for example, CO, H2 S, ammonia, etc. or pH detection can also be performed to coincidence. The deflection of such a detection value is inputted through other interfaces 82 and 83 and ..., and performs fuzzy reasoning by CPU9. The ambiguous control regulation of a predetermined number is written in memory 10 as discrete numeric data also for the variable of each input deflection, and inference selection of the optimal output is made for it from an input value. Each inference result compounds it and outputs it as a necessary control input. Although a method of elastic center and a weighted mean are used in order to compound the inference result obtained in each of this Ruhr, the former method of elastic center is effective in the control which is easier to understand qualitatively and is hard to mathematize. Although the output of CPU9 is outputted to the motor control circuit for aeration through an interface 11, an output can be displayed on a display and a controller can be operated by dialogic operation with an operator. A screen is displayed on a display and it can always be turned out immediately which regulation is mainly working. The display section displays the number of the control regulation which a controlled variable, a control input, and the set point are displayed, and also it is at the sampling time and is most effective with the change of a switch. In addition, pH of treated water is 4-9.5 by life and death, such as a fungus and a microorganism. It is usual although it changes in the range. 6.5 to about seven are good and the activity of an enzyme reaction changes with pH, temperature, etc.

[0014] Moreover, it generates by reactions, such as decomposition, oxidation, and reduction, for example, the reaction CO2+2H2 O->CH2 O+O2+H2 OCH2 O+O2 ->CO2+H2 O is performed by photosynthesis of algae, and generating gas is CO2. Gas occurs. Moreover, various gas occurs as following also by the enzyme reaction.

C6 H12O5+6O2 ->6CO2+6H2 O2NH4+2O2 ->4H2 O+N2SS+2H2 O+6NO3 ->5SO4+3N2+4H[0015] Drawing 3 shows an aerobic cycle, ammonia, CO2, and H2 S generate it by disassembly of a nitride, a carbon compound, and sulfur, and a nitric acid, CO2, and sulfur generate it by the oxidation, decomposition, and reduction. Therefore, such generating gas can be respectively detected by the sensor, the deflection can be inputted into CPU9, the signal input of the best DO control based on experience of an operator can be

obtained by performing fuzzy reasoning, and the best waste water treatment can be carried out to computer control using the knowledge by years of experience or the pile of intuition.

[0016] The above uses the anaerobic bacterium with which active sludge differs, although it explained processing aerobic treatment using fuzzy control, and it is methane CH4 about the organic substance under wastewater. Carbon-dioxide-gas CO2 Fuzzy control can be used similarly [in the case of the anaerobic treatment to decompose]. In addition, what is necessary is just to always maintain DO value below at constant value in the case of this anaerobic treatment.

[0017]

[Effect of the Invention] As mentioned above, in waste water treatment, while this invention forms the detector which detects at least one of DO of treated water, temperature, generating gas, and the pH The interface which inputs a variation [set point / value / of this detector / detection] as an ambiguous amount, The storage which wrote in the ambiguous control regulation of the predetermined number set up for the variable of input deflection as numeric data, The arithmetic and program control which performs fuzzy reasoning which makes inference selection of the optimal output from the input value from said interface using the data of this store, compounds each inference result, and is outputted as an amount of DO control operation, Since it is characterized by forming the fuzzy control machine which consists of the interface which supplies the output of this arithmetic and program control to DO control device or a display Experience of a skillful operator and the know-how of intuition can be taken in to control, and the best DO control can always be carried out by the automatic control by the computer. Therefore, when aerobic bacteria are used, oxidation multiplication is made prosperous by the best DO control, and processing effectiveness is raised, and in the case of anaerobic treatment, it is conversely effective in the ability to acquire the treatment effect stabilized as always maintained DO value below at constant value.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the process block diagram of one example of the waste water treatment equipment concerning this invention.
[Drawing 2] It is the block diagram of one example of the fuzzy control machine of the waste water treatment equipment concerning this invention.
[Drawing 3] It is the explanatory view of the aerobic cycle carried out in the waste water treatment equipment concerning this invention.
[Description of Notations]
1 Wastewater
2 Five Settling tank
3 Seven Active sludge
4 Aerator
6 Discharge
81, 82, 83 Interface
9 CPU
10 Storage
11 Interface

[Translation done.]

Fig. 1

【図1】

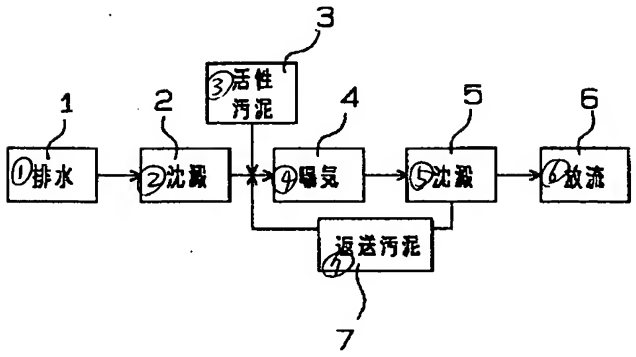
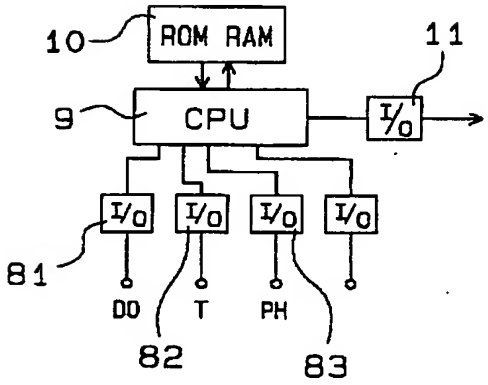


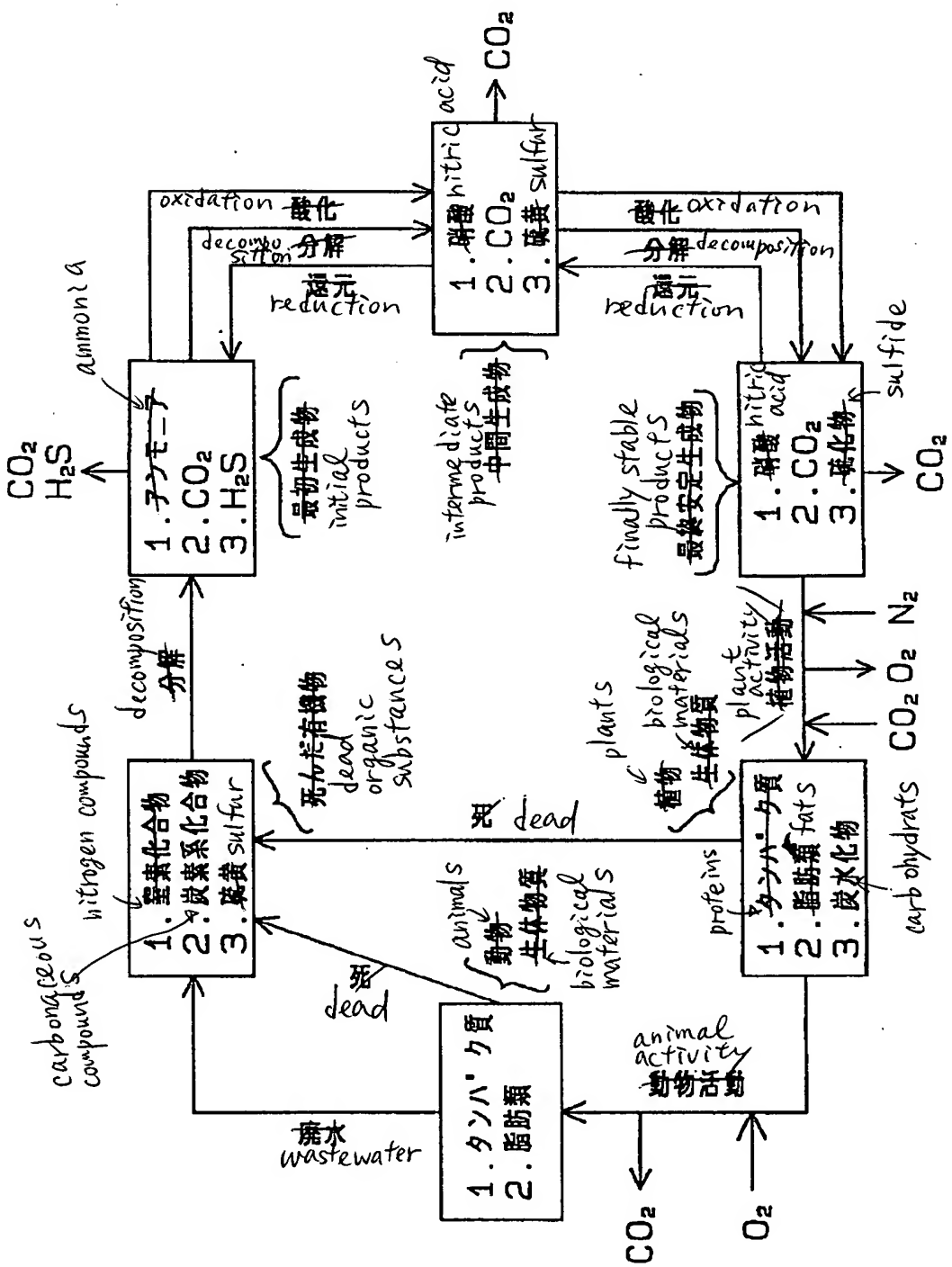
Fig. 2

【図2】



① wastewater
② settling
③ Active sludge
④ Aeration
⑤ settling
⑥ discharge
⑦ return sludge

図3 Fig. 3


CO2
1. 硝酸 nitric acid
2. CO2
3. 硫黄 sulfur
oxidation 酸化
decomposition 分解
還元 reduction
ammonia
CO2
H2S
1. アンモニア
2. CO2
3. H2S
最初生成物 initial products
intermediate products 中間生成物
finally stable products 最終安定生成物
1. 硝酸 nitric acid
2. CO2
3. 硫化物 sulfide
CO2
decomposition 分解
死んだ有機物 dead organic substances
dead 死
plants 植物
biological materials 生体物質
plant activity 植物活動
CO2 O2 N2
1. 窒素化合物
2. 炭素系化合物
3. 硫黄 sulfur
nitrogen compounds
carbonaceous compounds
1. タンパク質
2. 脂肪類 fats
3. 炭水化物 carbohydrats
proteins
animals 動物
biological materials 生体物質
dead 死
1. タンパク質
2. 脂肪類
animal activity 動物活動
廃水 wastewater
CO2
O2